

# **MASTER OF SCIENCE IN OPERATIONS RESEARCH**

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## **AN EVALUATION OF MARKOV CHAIN MODELING FOR F/A-18 AIRCRAFT READINESS**

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**Master of Science in Operations Research-September 1998**

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During its 1998 deployment the USS INDEPENDENCE (CV 62) and Carrier Air Wing Five operated under the control of Commander, Task Force 50 (CTF-50). To balance resources and readiness, CTF-50 asked the following question: “How many days can the USS INDEPENDENCE go without ‘off ship’ logistics support before the number of Mission Capable aircraft can be expected to fall below Chief of Naval Operations (CNO) readiness goals?” This thesis develops a Markov chain model to answer this question. Explanatory variables for this model include sorties flown, cannibalization rate and frequency of “off ship” logistics support. Using data from the USS INDEPENDENCE this thesis analyzes the readiness by estimating the number of F/A-18 aircraft capable of performing at least one of its intended missions.

Both non-linear Markov models and Generalized Linear Models are employed to estimate the effect of the operating environment on the number of mission capable aircraft available. The analysis demonstrates how the Markov approach captures the cyclic nature of aircraft operations and maintenance. Specifically, it is shown that the USS INDEPENDENCE can expect to operate 5 – 8 days without “off ship” logistics support before F/A MC rates fall below CNO readiness goals. Recommendations for further studies are included.

**DoD KEY TECHNOLOGY AREA:** Modeling and Simulation

**KEYWORDS:** Aviation Readiness, Markov Chain Models, Logistics Support, Carrier Onboard Delivery (COD)

## **AN OPTIMIZATION-BASED DECISION SUPPORT MODEL FOR THE NAVY H-60 HELICOPTER PREVENTIVE MAINTENANCE PROGRAM**

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For Naval aircraft, the largest portion of Operating and Support (O&S) costs is consumed by maintenance. The effort to reduce O&S costs is part of a Naval Air Systems Command initiative termed Affordable Readiness. Innovative programs are being implemented under Affordable Readiness to maintain safety, sustain readiness, and reduce costs.

One program, Integrated Maintenance Concept (IMC), is being developed for the Navy H-60 helicopter. IMC calls for depot-level artisans to be collocated at each squadron facility rather than at a

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central facility. Integrating appropriate organizational level maintenance tasks with germane subsets of the depot level tasks is the essence of the H-60 IMC. Reduced aircraft maintenance costs and out-of-service time are the major benefits of IMC.

As part of the transition to IMC, current organizational, intermediate and depot maintenance requirements are being reviewed for applicability and effectiveness. The result of this review will be a new listing of justified preventive maintenance tasks. The tasks then are grouped in an optimal manner that minimizes total aircraft out-of-service time.

This thesis explores the potential synergism inherent to certain preventive maintenance task groupings that can lead to an overall reduction in aircraft out-of-service time. A prototypic optimization-based decision support model is developed. The solution presented is evaluated in terms of total cost in hours to perform all required tasks over a given time horizon. Additionally, the optimal task groupings are identified. Together, these results are insightful for developing a preventive maintenance program.

**DoD KEY TECHNOLOGY AREA:** Other (Logistics)

**KEYWORDS:** Maintenance, Aviation, Optimization, Modeling, Logistics

### OPTIMIZING AMMUNITION MOVEMENT IN SUPPORT OF THE U.S. PACIFIC FLEET'S POSITIONING PLAN

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To support United States national and military strategy, the United States Navy must position ammunition at bases located in regions of potential conflict. The Commanders in Chief, U.S. Pacific Fleet (CINCPACFLT), U.S. Atlantic Fleet (CINCLANTFLT), and U.S. Naval Forces Europe (CINCUSNAVEUR) are responsible for developing positioning plans, in consultation with the Naval Ordnance Center (NAVORDCEN), to strategically position appropriate types and quantities of ordnance to support the warfighter and to meet both peacetime and wartime requirements. This thesis examines ammunition positioning in the Western Pacific. Changes to the positioning plan change the mix of ammunition types required to be stored at various bases. In order to satisfy the new requirements, ammunition must be relocated. There is not presently enough ammunition available to satisfy all requirements, so the relocation of available assets must be prioritized. This thesis discusses a model developed to optimize the ordnance positioning and transportation options. The model is used to better locate current stocks of ammunition in order to satisfy the CINCPACFLT Ammunition Positioning Plan.

**DoD KEY TECHNOLOGY AREA:** Modeling and Simulation

**KEYWORDS:** Ordnance, Ammunition, Transportation, Optimization, Modeling, Logistics

### SOFTWARE COMPONENTS FOR AIR DEFENSE PLANNING

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Modern offensive weapon technologies such as stealth and precision guided munitions have rendered Integrated Air Defense Systems increasingly vulnerable and ineffective. Stealth effectively reduces the performance of radar, but does not have the same impact on passive systems. Sensors have been the most

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important and vulnerable part of air defense systems throughout the history of air warfare. Research into passive sensors has been encouraging, but before passive sensor systems are produced, procured and deployed, analysis and planning must be conducted to quantify potential benefit and determine feasible system configurations. As this type of analysis encompasses extremely complex system behavior, developing reusable and flexible simulation models becomes important. This thesis develops a prototype software component architecture and component library for building simulation models for air defense analysis. Sensor and airborne weapon simulation components are demonstrated and used in an exploratory analysis of the impact of a network of Infrared Search and Track sensors. The analysis is based on a modern air defense system deployed in a realistic scenario. The component architecture and documentation methodology supports reuse, and provides model configuration flexibility with potential for growth in successive stages of analysis.

**DoD KEY TECHNOLOGY AREA:** Modeling and Simulation

**KEYWORDS:** Air Defense Planning, Simulation, Software Components

### CLIMATE SURVEY ANALYSIS FOR AVIATION MAINTENANCE SAFETY

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Naval Aviation has been challenged to cut its 1996 human factors related Class A flight mishap rate in half by the year 2000. Investigations show that human caused flight mishaps have not declined as rapidly as mechanical ones. From fiscal year 1990 through 1997, maintenance was a causal factor in 17 percent of Class A flight mishaps. Presently, there is an ongoing effort to identify factors contributing to human error in aviation maintenance. One major component is the development of an instrument to assess safety climate and posture in maintenance operations. This thesis is the climate safety assessment portion of this effort. It utilizes and adapts an existing Model of Organizational Safety Effectiveness (MOSE) to achieve an understanding of the possible influences of organizational factors on aviation maintenance. This thesis develops and administers a prototype Maintenance Climate Assessment Survey (MCAS) that provides a tool for assessing safety in maintenance operations. The study has 268 participants from three Reserve squadrons that represent the spectrum of aviation communities. The prototype MCAS is comprised of 67 questions developed from 155 candidate questions. Each question uses a Likert type rating scale, which allows participants to express opinions for each item presented. Cluster and Factor analysis is used to identify redundancies between items and how items clustered according to the MOSE components. The product of this study is a finalized MCAS with 35 questions that can be used by the Squadron command and Aviation Safety Officer to assess their unit's safety posture in conducting scheduled/unscheduled maintenance operations.

**DoD KEY TECHNOLOGY AREAS:** Manpower, Personnel and, Training; Other (Human Factors)

**KEYWORDS:** Model of Organizational Safety Effectiveness, Human Factors, Cluster Analysis, Factor Analysis, Aviation Maintenance, Maintenance Climate Assessment Survey

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### **A RELIABILITY AND AVAILABILITY ANALYSIS OF NOTIONAL JOINT STRIKE FIGHTER AIRCRAFT DESIGNS**

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This thesis investigates the reliability and availability differences of notional Aircraft Carrier Takeoff and Landing (CVTOL) and Short Takeoff and Vertical Landing (STOVL) versions of the Joint Strike Fighter (JSF) aircraft using basic Reliability Block Diagrams (RBD), survivor functions, and stochastic methods. The models used in this thesis can be developed for forecasting the reliability and availability of any notional aircraft. The aircraft component data were extracted from the Naval Aviation Logistics Data Analysis (NALDA) database. Stochastic model sensitivity analysis of critical notional aircraft components and comparison of aircraft survivor function calculations indicate the STOVL JSF has a higher attrition rate and a significantly lower availability than the CVTOL JSF.

**DoD KEY TECHNOLOGY AREAS:** Aerospace Propulsion and Power, Air Vehicles

**KEYWORDS:** Joint Strike Fighter, JSF, Reliability, Availability, STOVL

### **AN ALGORITHM FOR CLASSIFYING PUBLIC SWITCHED TELEPHONE NETWORKS (PSTN) SWITCHING STATIONS**

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The National Security Agency (NSA) collects and processes signals intelligence information for national security purposes. As part of this mission, NSA predicts message routing over public switched telephone networks (PSTNs). The hierarchical switching level (or classification) of PSTN switching stations must be determined before making routing predictions. This thesis develops a fast graph-theoretic algorithm for accomplishing this classification. An undirected connected graph models a target PSTN; switching stations are nodes and logical connections between the switching stations are unit-length arcs. We develop bounds for the minimum number of switching levels and implicitly enumerate all possible classifications for each PSTN. The algorithm is implemented in Java and PSTNs are classified using a personal computer. Solutions are obtained in under one second for nine real-world PSTNs, and large notional networks of over 300 nodes and 900 arcs are classified in under one minute. This research improves existing node classification software.

**DoD KEY TECHNOLOGY AREA:** Command, Control, and Communications

**KEYWORDS:** Public Switched Telephone Network, PSTN, Hierarchical PSTN, Telecommunications, Java, Graph Theory, National Security

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### **COORDINATED INLAND AREA SEARCH AND RESCUE (SAR) PLANNING AND EXECUTION TOOL**

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This thesis designs and implements the Coordinated Inland Area Search and Rescue (SAR) System (COINSS). This system provides several important features not provided by current inland SAR computer systems. First is the ability to model movement of the target. Second is modeling the effect terrain has on the movement of the target. Third is the visual presentation of a probability map, a color display showing the probability that the target is located at various geographic positions. COINSS is developed in the Java programming language. It is designed to be implemented with a map-based planning system using loosely coupled components. COINSS provides the initialization, movement, and search algorithms which are used by the planning system to support the search operation. The initialization algorithms define the search area where the SAR operation will occur. Initial areas are defined for the target. COINSS models the movement of the target as a discrete time Markov chain. Bayes theorem is used to update the probability map when negative search information is provided. This thesis will improve inland SAR operations by providing the first model with an interactive graphical user interface and a model of target movement.

**DoD KEY TECHNOLOGY AREA:** Modeling and Simulation

**KEYWORDS:** Search and Rescue, Java, Loosely Coupled Components, Map Based Planning

### **A COMPARISON OF THE FORCE DEPLOYMENT ESTIMATOR (FDE) AND NAVAL POSTGRADUATE SCHOOL / RAND MOBILITY OPTIMIZER**

**(NRMO) AS TOOLS FOR MOBILITY ANALYSIS**

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Over the past decade, changes in the global power structure have driven the United States into a major reassessment of its force structure and global force projection requirements. There is a resulting need for force deployment models that offer quick, accurate analysis of force projection options and proposed force structure changes. One model, the Force Deployment Estimator (FDE), a combination discrete event simulation and goal program, is currently used by the J8, Warfighting Analysis Division (J8/WAD). A second model with similar capabilities, the Naval Postgraduate School/RAND Mobility Optimizer (NRMO), is a linear program that was written for the Air Force Studies and Analysis Agency. In order to compare the two models and give J8/WAD the option of a second model for use in analysis, NRMOAS (NRMO Air/Sea) was created by adding a sealift component to NRMO. NRMOAS creates both an air and sea network and can be run with the user designating the unit's mode of travel, the model determining the same or a combination of both. This thesis compares the results of several different scenarios run through FDE and NRMOAS. In all cases, NRMOAS out performed FDE in terms of timely delivery of personnel and cargo. Additionally, NRMOAS allows a far higher level of resolution in network structure. The recommendation is that NRMOAS be used by J8/WAD for detailed mobility analysis. Also recommended are changes to FDE.

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**DoD KEY TECHNOLOGY AREAS:** Modeling and Simulation, Other (Optimization)

**KEYWORDS:** Mobility, Optimization, Force Deployment

**SOPITE SYNDROME IN OPERATIONAL FLIGHT TRAINING**  
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**Second Reader: Samuel E. Buttrey, Department of Operations Research**

Sopite Syndrome is a poorly understood response to motion characterized by drowsiness, fatigue, sleep disturbances, and mood changes. It is distinct from “regular” motion sickness or common fatigue, and may affect the performance of motor vehicle as well as aircraft operators. The potential impact Sopite Syndrome may have on military aviation is relatively unknown. Recently, research in situations relevant to aviation training and flight operations has been initiated. The present study is part of that effort. Its goal is to determine the incidence, severity, and association of Sopite Syndrome characteristics in a population of Student Naval Flight Officers (SNFOs). Seventy-eight SNFOs assigned to Training Squadrons Four and Ten located at the Naval Air Station Pensacola, Florida completed a questionnaire designed to capture evidence/incidence of fatigue, motion sickness, drowsiness, and sleep disturbances during days when SNFOs flew versus non-flying days.

The questionnaire data was coded/tabulated for entry on a spreadsheet for subsequent analysis. Descriptive and non-parametric statistical techniques were used to analyze the data set obtained. The results show sufficient evidence between the levels of symptomology and their relationships when comparing conditions that support the existence of Sopite Syndrome in operational flight training.

**DoD KEY TECHNOLOGY AREA:** Other (Human Factors)

**KEYWORDS:** Sopite Syndrome, Motion Sickness

**THE EFFECTS OF SOPITE SYNDROME ON SELF-PACED**  
**AIRSICKNESS DESENSITIZATION PROGRAM**  
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**M.A., National University, 1994**  
**Master of Science in Operations Research-September 1998**  
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**Robert R. Read, Department of Operations Research**  
**Second Reader: Samuel E. Buttrey, Department of Operations Research**

The U.S. Navy implemented the Self-Paced Airsickness Desensitization (SPAD) program in 1989 for aviation students whose incidence of airsickness was not easily resolved. Some participants may have also experienced symptoms that are not typically recognized as motion sickness, including prolonged drowsiness and/or mood changes. These effects are part of a poorly understood response to motion termed “Sopite Syndrome.” This thesis explores the effects of Sopite Syndrome on student aviators diagnosed with motion sickness. Sixty SPAD program participants completed a survey comprised of scales, which estimate motion sickness, drowsiness, fatigue, and sleep disturbances during SPAD treatment days. Results indicate: (1) symptoms consistent of Sopite Syndrome were reported by 45% of the participants and (2) the

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presence of Sople Syndrome in a SPAD participant was not an accurate predictor for successful treatment and return to flight status.

**DoD KEY TECHNOLOGY AREA:** Other (Human Factors)

**KEYWORDS:** Sople Syndrome, Motion Sickness, Aisickness, Aisickness Rehabilitation Programs

### NAVAL SPECIAL WARFARE LOGISTIC PLANNING SYSTEM

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In today's world, small-scale contingencies and operations-other-than-war have replaced major theater war as the driving United States (U.S.) military scenario and account for approximately 80% of operational tempo. Special Operations Forces play the key role in these limited actions. Similarly, the number of possible locations and levels of conflict have also increased. With the drawdown of permanent U.S. military bases throughout the world, the resulting reduction in logistic support has evolved as a major problem. Logistic support of naval special operations forces has not kept pace with this changing environment. An accurate and timely logistic planning aid is needed to assist in mission planning. Such a planning aid must utilize logistic planning factors for all classes of supply derived from conventional military sources, as well as, naval special warfare sources. These logistic planning factors are the input for the subsequent EXCEL spreadsheet program designed to serve as a stand-alone, logistic requirement planning aid. This program can be used by naval special warfare staff, joint staff, and other mission planners to quickly calculate logistic supply and service requirements for a multitude of naval special warfare missions, area of operations, and threats.

**DoD KEY TECHNOLOGY AREA:** Other (Logistics)

**KEYWORDS:** Naval Special Warfare Forces, Logistic Planning Factors, Logistic Planning Requirements

### PATRIOT PAC-3 MULTI-FUNCTION SIMULATION ANALYSIS: A TIME SERIES APPROACH TO A DETERMINISTIC MODEL (U)

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Defenses against tactical ballistic missile attacks are a primary national security need. The last line of defense against missiles in terminal phase is the next-generation PATRIOT (PAC-3) air defense system. A PAC-3 radar simulation called Multi-function Simulation (MFSIM) is undergoing the Army Verification, Validation and Accreditation Process. This model builds on a previous Patriot simulation.

This thesis identified unusual model behavior in MFSIM. Missile intercept altitudes did not occur as expected under stressful scenarios. One possible cause, radar dwell times under stress, was found not to be the source of the unusual behavior.

**DoD KEY TECHNOLOGY AREAS:** Conventional Weapons, Modeling and Simulation

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**KEYWORDS:** MFSIM, PATRIOT, PAC-3, Tactical Ballistic Missile, TBM, Ballistic Missile Defense Organization, BMDO, Theater Missile Defense, TMD

### **MODELING SEA-BASED SUSTAINMENT OF MARINE EXPEDITIONARY UNIT (SPECIAL OPERATIONS CAPABLE) (MEU(SOC)) OPERATIONS ASHORE**

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The Marine Corps has embraced the concepts of Operational Maneuver From The Sea (OMFTS) and Ship-to-Objective Maneuver (STOM) as the next progression in the evolution of amphibious warfare. These related concepts envision harnessing emerging technologies to allow the projection of naval power ashore faster and from greater distances than in the past. Additionally, both concepts identify the ability to conduct sea-based logistics (SBL) as a key requirement for successful implementation. Sea-based logistics involves executing a wide range of logistical functions from a sea-base rather than from sites traditionally established ashore. Acknowledged enhancements are required to realize a complete SBL capability; however, the ability to provide some measure of sea-based sustainment exists today. This thesis models the sea-based sustainment of Marine Expeditionary Unit (Special Operations Capable) (MEU(SOC)) forces deployed from Amphibious Ready Group (ARG) ships. Missions are developed for analysis; each is coupled with an appropriate force package of personnel and equipment density. Sustainment requirements and available transportation capacities are then determined and compared for each mission. This comparison along with several excursions provides insight into the nature of sea-based sustainment feasibility. It also gauges potential limitations for sea-based sustainment.

**DoD KEY TECHNOLOGY AREA:** Other (Logistics)

**KEYWORDS:** Sustainment, Operational Maneuver From The Sea (OMFTS), Ship-to-Objective Maneuver (STOM), Sea-Based Logistics, Sea-Based Sustainment

### **PATIENT SATISFACTION: A VISUAL ANALYSIS USING TRELLIS GRAPHICS**

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During times of peace, health care is one of the foremost quality of life issues to active duty members, their families and retirees. Patient satisfaction surveys are used to determine how patients perceive salient aspects of their medical care. There has been substantial anecdotal evidence to suggest that patients are unhappy with their care, but past analysis of the DoD Annual Surveys using simple frequencies of responses indicated that, overall, patients were satisfied. This thesis, using a powerful new technique called Trellis Graphics that allows more than three variables to be visualized simultaneously, has uncovered startling results that go beyond previous analysis, provide evidence to support the anecdotal claims, and show that overall satisfaction is not a reliable measurement for determining patient satisfaction. The seven factors defined by the National Committee on Quality Assurance are each individually, and together as a group, more reliable measures. The inability to choose a provider was clearly rated by every beneficiary



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group as the single greatest source of dissatisfaction. There are also differences in satisfaction between the sexes, and among the different groups. Active duty members, who are the primary customers of military treatment facilities, are the most dissatisfied, and women tend to be less happy than men.

**DoD KEY TECHNOLOGY AREA:** Other (Health Care, Statistics)

**KEYWORDS:** Patient Satisfaction, Military Health Care, Survey, Trellis Graphics

### **A SIMULATION ANALYSIS OF A SUPPRESSION OF ENEMY AIR DEFENSE (SEAD) OPERATION**

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Master of Science in Operations Research-September 1998**

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**Patricia A. Jacobs, Department of Operations Research**

**Second Reader: Arnold H. Buss, Department of Operations Research**

Traditional SEAD operations rely on Wild Weasel aircraft equipped with Anti-Radiation missiles. This combination of real-time target acquisition capability with high precision weaponry has rendered surface-based radar systems vulnerable and ineffective. As a result, SEAD operations are decoupled from the slow and error-prone intelligence gathering and evaluation process proceeding conventional air-to-ground targeting. However, new technology allows modern air defense systems to combine increased mobility with a minimal use of radar, reducing the number of targets available to Wild Weasel aircraft. Consequently, more of the operational load is shifted over to conventional air-to-ground assets, making the SEAD operation more sensitive to the typical error and delay sources in the conventional targeting process.

This thesis uses a low-resolution simulation model to evaluate the impact of information delay on a SEAD operation. The results show that the effectiveness of a SEAD operation is sensitive to information delay, but not to the anticipated degree. Not surprisingly, the dominating variable for the success of the SEAD operation is the number of allocated SEAD aircraft. Next, but an order of magnitude less influential, is the delay in the SEAD intelligence cycle. Finally, the frequency of movement of the air defense units seems to play a minor role.

**DoD KEY TECHNOLOGY AREA:** Modeling and Simulation

**KEYWORDS:** Suppression of Enemy Air Defense, Intelligence Cycle, Simulation

### **ANALYSES OF WEIGHT, BODY-FAT, AND PHYSICAL FITNESS TESTING STANDARDS, FOR ACTIVE DUTY MALE MARINES, WITH PROPOSED ALTERNATIVES**

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The Marine Corps utilizes a three-event Physical Fitness Test (PFT) comprised of a 3-mile run, sit-ups, and pull-ups to assess the level of physical fitness of individual Marines. This thesis uses newly collected data from the Marine Corps to analyze the current weight and body-fat standards and compare them with proposed alternatives. The research investigates whether the current standards can be slightly relaxed without resulting in significant decreases in physical fitness performance. Additionally, this thesis investigates the validity of pull-ups as an indicator of muscular strength and endurance. The analysis compares the performance scores for two types of pull-ups (the dead-hang and kip methods) with other

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physical performance events which require upper body strength and muscular endurance. The thesis also presents proposed scoring alternatives for the pull-up event based on an analytical comparison of performance distributions for the run and sit-up events, in order to level the equality for all three PFT events. Additionally, a new 3-profile PFT alternative comprised of aerobic, muscular, and body composition profiles is presented as an improved measure of assessing the physical fitness of individual Marines.

**DoD KEY TECHNOLOGY AREA:** Manpower, Personnel, and Training

**KEYWORDS:** Weight, Body-Fat, Physical Fitness Test, Pull-ups, Physical Fitness, Weight Control Program, Height-Weight Tables, Physical Performance, Muscular Strength, Muscular Endurance, Percent Body-Fat, Maximum Weight Limits, Percent Body-Fat Limits, Upper-Body Strength, Body Composition, Modified Pull-ups

### **SIMULATING AN ISOCHRONAL SCHEDULED INSPECTION SYSTEM FOR THE P-3 ORION**

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The purpose of this thesis is to explore potential challenges facing the implementation of an Isochronal Scheduled Inspection System (ISIS) for the United States Navy's P-3 Orion. Implementation of ISIS, which is based solely upon calendar time, has been proposed to replace the present system of scheduled inspections that are based upon both calendar time and flight hours. The United States Customs Service and the Royal Netherlands Navy have successfully fielded the ISIS program and demonstrated that the concept works when implemented on a small scale. It is not known, however, how well the program might work when applied to a larger organization. This thesis obtains insights into potential troubles arising from implementation of the ISIS program by building and analyzing a simulation model. The model's output includes the number of times aircraft induction dates are rescheduled, and the number of days that scheduled aircraft induction dates are changed by. The analysis provides a measure with which to gauge the difficulty of implementing the ISIS program in the U.S. Navy.

**DoD KEY TECHNOLOGY AREAS:** Air Vehicles, Modeling and Simulation

**KEYWORDS:** Aviation, Scheduled Maintenance, Simulation, Java, Isochronal

### **TWO NEW NEAREST NEIGHBOR CLASSIFICATION RULES**

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Nearest-Neighbor (NN) classification is a non-parametric discrimination and classification technique. In NN classification a test item is compared by some similarity measure of its multiple variables (usually a distance metric) with all the items in a training set. The class of the item to which it is most similar can be used as an indication of the class of the test item. In other words, the test item is assigned the class of its

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nearest neighbor. A key extension is the case when  $k > 1$  nearest neighbors ( $k$ -NN) are examined with the classification usually being made based on a plurality.

NN classification is used in many fields, including for example the field of Pattern Recognition. Applications include tasks like speech recognition by a computer, medical data interpretation and diagnosis, or the interpretation of remote sensing imagery from satellites. Military applications of the technique include any situation where automated recognition is required.

This thesis proposes two new NN rules that are intended to improve classification accuracy. The rules are tested against baseline classification methods in common use with a variety of data sets. One method shows improvement over the baseline methods in most of the data cases examined.

**DoD KEY TECHNOLOGY AREAS:** Computing and Software, Sensors, Other (Statistics)

**KEYWORDS:** Nearest Neighbor Classification, Discrimination, Pattern Recognition

### A COMPARISON OF AN ALTERNATIVE INVENTORY CONTROL CONCEPT WITH THE NAVY'S EXISTING WHOLESALE INVENTORY CONTROL PROCEDURES FOR REPAIRABLES

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Second Reader: Patricia A. Jacobs, Department of Operations Research

The Director of Planning and Operations Research Department, Naval Inventory Control Point (NAVICP) Code M041, requested a study to compare the performance of two sets of inventory control procedures for managing high-cost repairable items. One of these sets is embedded in the Navy's existing wholesale inventory control system. The procedures of this set characterize a periodic review process, which calculates four decision variables in order to manage Navy inventories. These variables represent how much to order, how much to repair, when to order, and when to repair. The other set of procedures are adapted from a commercial software package called Bandwidth Management developed by Stewart-Frazier Tools Inc. Two versions of these latter procedures are modeled in this thesis. These procedures characterize a periodic review process, which calculates three decision variables. These variables represent how much to deliver, how much to repair, and when to repair. This thesis uses simulation to model the two sets of procedures and to compare their performance with respect to three formal measures of effectiveness adopted by NAVICP: Supply Material Availability (SMA), Average Delay for a Delayed Requisition (ADDR), and Average Monthly Investment Level (AMIL). The comparison results of the thesis indicate that the existing Navy inventory procedures generate better performance in all three formal measures of effectiveness.

**DoD KEY TECHNOLOGY AREA:** Modeling and Simulation

**KEYWORDS:** Navy Repairable Items, Inventory Models

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## **MASTER OF SCIENCE IN OPERATIONS RESEARCH**

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### **HUMAN FACTORS ANALYSIS OF UNITED STATES NAVY AFLOAT MISHAPS**

**Rex D. Lacy-Lieutenant Commander, United States Navy**

**B.S., Georgia Institute of Technology, 1982**

**M.S., Central Michigan University, 1988**

**Master of Science in Operations Research-September 1998**

**Advisor: Samuel E. Buttrey, Department of Operations Research**

**Second Reader: CDR John K. Schmidt, School of Aviation Safety**

The effects of maritime mishaps, which include loss of life as well as environmental and economic considerations, are significant. It has been estimated that over 80 percent of maritime accidents are at least partially attributable to human error. Human error has been extensively studied in a number of fields, particularly aviation. The present research involves application of the Human Factors Accident Classification System (HFACS), developed by the Naval Safety Center, to human error causal factors identified in selected investigation reports of significant mishaps occurring on U.S. Navy afloat and diving units from 1992 to 1996. An evaluation of the reliability of the classification system was performed by measuring the level of agreement between two independent raters' application of the system to mishap analysis. Descriptive statistics and categorical data analysis were performed and meaningful insights were revealed regarding the types of human error that were associated with afloat naval mishaps. Comments and recommendations regarding implementation of the classification system for use in maritime accident analysis are provided.

**DoD KEY TECHNOLOGY AREA:** Other (Accident Analysis)

**KEYWORDS:** Maritime Mishaps, Accident Analysis, Human Factors, Human Error

### **ARMY SPECIAL OPERATIONS LOGISTICS PLANNING AID**

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**Master of Science in Operations Research-September 1998**

**Advisor: LTC Charles H. Shaw, III, Department of Operations Research**

**Second Reader: David A. Schrady, Department of Operations Research**

Given the clandestine nature of Special Operations Forces' (SOF) missions and the inability to adequately predict possible contingency scenarios, it is imperative that SOF logistics support be flexible and responsive. Currently, SOF logistics support is inequitable across Service lines, of limited joint flexibility, and has no single point of contact for logistics planning, coordination, and command and control resulting in inconsistent support for SOF operations. The possible implementation of a Joint Special Operations Logistics Command (JSOLOGCOM) has the potential to greatly improve support to SOF using all existing resources and is consistent with logistics concepts espoused in Joint Vision 2010 and SOF Vision 2020. The first step in evaluating the JSOLOGCOM concept for feasibility is a determination of logistical requirements for SOF units' missions. This thesis provides SOF logistics planners with generic planning factors for all classes of supply and specific planning factors for Class V, Ammunition, and Class VIII, Medical. It outlines a methodology that can be used to determine mission specific planning factors for any class of supply as well as field services. This thesis has also provided SOF logistics planners with a computer based, user-friendly, and flexible logistics planning aid that can be used to create more accurate logistics estimates than they have been able to in the past.

**DoD KEY TECHNOLOGY AREA:** Other (Logistics)

**KEYWORDS:** Logistics, Special Operations Forces, Army, Planning Factors

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### **COMPARISON OF PROFICIENCY OBJECTIVES, PERFORMANCE OBJECTIVES, AND SUCCESS AT FOLLOW-ON TRAINING**

**Johnna M. Marchant-Lieutenant, United States Navy  
B.S., Portland State University, 1986**

**Master of Science in Operations Research-September 1998**

**Advisor: Samuel E. Buttrey, Department of Operations Research**

**Second Reader: John Thain, Department of Evaluation and Research, Defense Language Institute**

The Defense Language Institute Foreign Language Center (DLIFLC) trains students in over 21 foreign languages for the Department of Defense (DoD). The National Security Agency (NSA) and Defense Intelligence Agency (DIA) are responsible for setting the training objectives for students entering professional fields in intelligence.

In the past, general proficiency in listening, reading, and speaking skills has been the focus of language learning and testing in the DoD. Certain minimum scores on the Defense Language Proficiency Test (DLPT) are required for certain training and operational positions within the DoD. DoD has not established applicable performance objective scores for training and operational positions. Individual service commanders at DLIFLC may exercise some discretion in borderline cases where general minimum DLPT requirements have not been met. They may take into account performance objective scores and grant waivers for attending Goodfellow Air Force Base (GAFB) follow-on training.

The purpose of this study is to determine how the performance objective scores relate to success on the DLPT and how the combination of DLPT and performance objective tests might possibly relate to success on follow-on training at GAFB. Success at GAFB is defined by on-time graduation, number of required special-assistance hours, and performance on "block" tests.

**DoD KEY TECHNOLOGY AREA:** Manpower, Personnel, and Training

**KEYWORDS:** DLPT, Performance Objective

### **ANALYSIS OF PREDICTIVE FACTORS FOR FULLY MISSION CAPABLE RATES OF DEPLOYED AIRCRAFT**

**Patricia B. Moore-Lieutenant Commander, United States Navy  
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**Master of Science in Operations Research-September 1998**

**Advisor: Samuel E. Buttrey, Department of Operations Research**

**Second Reader: Lyn R. Whitaker, Department of Operations Research**

As the U.S. military reduces its forces, the ability to maintain an acceptable level of readiness is of concern to the U.S. Navy. Both personnel and equipment readiness and the ability to predict them have been the focus of much attention. Fully Mission Capable (FMC) rates measure the percentage of time that aircraft are fully able to meet mission requirements. FMC rates have been determined to be the best single measure of equipment condition, providing an indication of aircraft readiness. This thesis evaluates the capabilities of logistic regression and regression trees in predicting aircraft readiness for a specific carrier deployment or aircraft type/model/series (TMS). The data are taken from observations of squadrons by aircraft TMS by month from 1981 through 1997. Empirical results indicate that logistic regression and regression trees provide forecasting results with standard errors of prediction better than taking the mean and standard deviation of the historical data.

**DoD KEY TECHNOLOGY AREA:** (Other) Aircraft Readiness

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**KEYWORDS:** Aircraft Readiness, Fully Mission Capable Rates, Logistic Support, Logistic Regression, Regression Trees

### **BATTLE GROUP ORDNANCE AND FUEL LOGISTIC TASK MEASURES OF PERFORMANCE FOR THE UNIVERSAL NAVAL TASK LIST**

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**Master of Science in Operations Research-September 1998**

**Advisors: George Conner, Department of Operations Research**

**Kevin J. Maher, Department of Operations Research**

**Second Reader: Alan R. Washburn, Department of Operations Research**

A set of well-defined and quantifiably justified Measures of Performance (MOPs) is required for the armament and fuel tasks of a Carrier Battle Group (CVBG) as described in the Universal Naval Task List (UNTL). These MOPs are incorporated in the CVBG's training plan and provide the BGCDR a method to evaluate the CVBG's level of ability to perform the necessary tasks. This thesis proposes 37 MOPs and the methodology to subjectively evaluate the MOPs to determine which ones are well defined, and objectively evaluate them to determine how well they collectively measure task performance. The proposed MOPs are derived from the task descriptions and objectives found in the UNTL. They are subjectively scrutinized using the twelve criteria required by the UNTL and objectively evaluated using correlation analysis. A simulation is developed for each task to provide the data for the objective analysis. The results indicate that 23 of the 37 proposed MOP's meet the required criteria of being well defined and useful in measuring task performance. Based upon the developed methodology, it is recommended that the Naval Doctrine Command consider the 23 MOPs for inclusion into its revised UNTL.

**DoD KEY TECHNOLOGY AREAS:** Other (Measures of Performance)

**KEYWORDS:** Carrier Battle Group, Measures of Performance, Measures of Effectiveness, Ordnance, and Fuel

### **CLASSIFYING PUBLIC SWITCH TELEPHONE NETWORK (PSTN) SWITCHING STATIONS: A NATIONAL SECURITY AGENCY APPLICATION**

**Allen S. Olson-Major, United States Marine Corps  
B.S., University of Minnesota, 1982**

**Master of Science in Operations Research-September 1998**

**Advisors: R. Kevin Wood, Department of Operations Research**

**Norman D. Curet, National Security Agency**

**Second Reader: Gerald G. Brown, Department of Operations Research**

The U.S. National Security Agency wishes to predict the routing of messages over various communications networks. Before routing predictions can be made in a public switch telephone network (PSTN), the hierarchical level of the network's switching stations must be known. This thesis develops an integer linear programming model for accomplishing this classification. In this model, a PSTN is represented as a graph in which switching stations are nodes and the logical connections between the switching stations are arcs. Algebraic constraints represent the engineering standards common to PSTNs. The model also incorporates probabilistic inferences about the class of switching stations to improve classification accuracy for networks not following typical PSTN structural practices. Preprocessing routines that analyze the network's topology and employ various heuristics to reduce the size of the problem are evaluated. The

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sample PSTNs are solved using IBM's Optimization Subroutine Library solver on a 166 MHz desktop model is implemented in Generic Algebraic Modeling System Development Corporation's GAMS and personal computer. Accurate classification solutions are obtained in under two seconds for actual PSTNs, while extremely large notional networks of over 300 nodes and 900 arcs are solved in under two minutes.

**DoD KEY TECHNOLOGY AREAS:** Command, Control, and Communications, Modeling and Simulation

**KEYWORDS:** Hierarchical PSTN, Integer Program, Linear Programming, Telecommunications

#### **ANALYSIS OF MID-GRADE NAVAL AVIATOR RETENTION**

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**B.S., United States Naval Academy, 1984**

**Master of Science in Operations Research-September 1998**

**Advisors: William Krebs, Department of Operations Research**

**Samuel Buttrey, Department of Operations Research**

**Second Reader: CDR John K. Schmidt, School of Aviation Safety**

Attrition of aviators is of major concern to the Navy because of the costs and numbers involved. The Navy currently forecasts aviator retention and attrition by extrapolating historical trends. This thesis recommends that the Navy replace the current method with two alternative statistical techniques: *logistic regression* and *classification trees*. They are recommended for two reasons. First, the proposed techniques make significantly more accurate forecasts of aviator retention than the current method. Second, the proposed techniques, unlike the current method, can identify the significant variables affecting aviator retention. Use of the proposed techniques can therefore lead to the formulation of better aviator retention policies by the Navy. These arguments are demonstrated with a case study of an existing retention database. The variables identified as most significant for aviator retention in this analysis were the geographic location of an aviator's duty station, assignment to non-flying billets, and grade. Policy implications of these findings are discussed.

**DoD KEY TECHNOLOGY AREA:** Manpower, Personnel, and Training

**KEYWORDS:** Retention, Employee Turnover, Naval Aviation, Manpower, Logistic Regression, Classification Trees

#### **AN OBJECT-ORIENTED DISCRETE-EVENT SIMULATION OF LOGISTICS (MODELING FOCUSED LOGISTICS)**

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**B.S.E., Tulane University, 1982**

**M.S., Central Michigan University, 1995**

**Master of Science in Operations Research-September 1998**

**Advisor: Arnold H. Buss, Department of Operations Research**

**Second Reader: Gordon Bradley, Department of Operations Research**

Joint Vision 2010 puts forth four operational concepts describing how U.S. forces will conduct combat in the future. One of these concepts is Focused Logistics, which Joint Vision 2010 defines as "the precise application of logistics." In order to study the effects of Focused Logistics, a flexible method of simulating possible logistics systems is needed. The Flexible Experimental Logistics Simulator (FLEXLOGS) is an object-oriented, discrete-event simulation that is designed to be used to evaluate proposed future logistics strategies. First, the author develops a model capable of simulating any proposed logistics scheme with minimal modification to the software. Second, the thesis discusses the design and use of the model.

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Finally, the model is used to explore the shape of curves defined by the probability of combat victory verses “logistical footprint size” and “premium transportation availability.” The model implements the draft Logistical Conceptual Object Model being developed as part of the *Focused Logistics Study* by the Office of the Secretary of Defense, Program Analysis and Evaluation, Simulation Analysis Center.

**DoD KEY TECHNOLOGY AREAS:** Modeling and Simulation, Other (Logistics)

**KEYWORDS:** Focused Logistics, FLEXLOGS, Discrete-Event Simulation

**A HUMAN ERROR ANALYSIS AND MODEL OF NAVAL AVIATION  
MAINTENANCE RELATED MISHAPS**

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**Ph.D., Western Michigan University, 1993**

**B.S., Western Michigan University, 1989**

**Master of Science in Operations Research-September 1998**

**Advisors: George W. Conner, Department of Operations Research**

**CDR John K. Schmidt, School of Aviation Safety**

**Second Reader: CAPT Frank C. Petho, Department of National Security Affairs**

Naval Aviation is in the midst of a major transformation as it attempts to come to terms with the demands of maintaining operational readiness in the face of diminishing budgets and reduced manning. Diminishing operating and procurement budgets mean that Naval Aviation is for the most part “making do” with existing aircraft. Over the past decade, one in four Naval Aviation mishaps were partially attributable to maintenance error. The present operating environment underscores the need to address maintenance error and its causes.

The current study accomplishes three things. First, it evaluates 470 Naval Aviation mishaps with distinct maintenance error correlates. Second, it categorizes those errors using a taxonomy based upon current organizational and psychological theories of human error. Third, it mathematically models the consequences of these errors and uses the models to: (a) predict the frequency with which maintenance-based mishaps will occur in the future and (b) approximate the potential cost savings from the reduction of each error type.

**DoD KEY TECHNOLOGY AREAS:** Air Vehicles, Modeling and Simulation, Other (Human Systems Integration)

**KEYWORDS:** Aviation Accidents, Aviation Mishaps, Accident Classification, Accident Prediction, Maintenance Mishaps, Human Factors, Human Error, Poisson Process, Modeling, Cost Estimation

**DYNAMIC PLATFORM INDEPENDENT META-ALGORITHMS  
FOR GRAPH-PARTITIONING**

**Victor Scott Schwartz-Lieutenant, United States Navy**

**B.S., University of Nebraska, 1992**

**Master of Science in Operations Research, September 1998**

**Advisor: Gordon H. Bradley, Department of Operations Research**

**Second Reader: R. Kevin Wood, Department of Operations Research**

A dynamic platform-independent solver is developed for use with network and graph algorithms of operations research. This solver allows analysts to solve a large variety of problems without writing code. Algorithms from a library can be integrated into a meta-algorithm which also provides easy monitoring of solution progress.



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The solver, DORS, is demonstrated by heuristically solving a graphpartitioning problem to minimize the number of nodes adjacent to other segments of the partition. The model arises from a network-upgrade project faced by the Defense Information Systems Agency (DISA), a problem with over 200 nodes and 1400 arcs. Solutions are provided on a 266 MHz Pentium H PC using Windows NT 4.0. Eight variants of the problem are solved involving modification to the objective function, constraints on the size of partition segments, and on the number of those segments.

DORS (and the meta-algorithm it implements) appears to find a good solution for one of the two problem formulations for DISA, but has difficulty solving the other. Because the solver allows new algorithms to be easily added to create more powerful meta-algorithms, DORS should provide a good solution approach for both problem formulations given a more versatile library of algorithms.

**DoD KEY TECHNOLOGY AREAS:** Computing and Software, Modeling and Simulation

**KEYWORDS:** Graph Partitioning, Java

### **COST ANALYSIS OF INTER-DEPOT TRANSPORTATION OPTIONS FOR U.S. NAVY EAST COAST AIR-LAUNCHED MISSILES**

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**B.S., Virginia Polytechnic Institute and State University, 1990**

**Master of Science in Operations Research-September 1998**

**Advisor: David G. Brown, Department of Systems Management**

**Second Reader: Kevin J. Maher, Department of Operations Research**

Since the disintegration of the Warsaw Pact and the Soviet Union, the Department of Navy has had to learn how to meet its commitments with an ever-decreasing budget. One Navy community addressing this downsizing is the east coast ordnance community. Because of restructuring and the closure of Weapon Station Charleston, South Carolina, the remaining east coast weapon stations are handling the same amount of ordnance with fewer personnel. As a result of the restructuring, the aircraft carriers, ordnance ships, and large deck amphibious ships conduct ordnance transfers at Naval Weapon Station (NWS) Earle, New Jersey. These ships all carry air-launched missiles that have to be maintained at Naval Weapons Station Yorktown. This thesis develops cost equations associated with several different methods of transportation (commercial and Department of Defense). These equations are being used to generate cost curves for each of four types of missiles being transported between NWS Earle and NWS Yorktown. The curves are analyzed, and decision policies are determined which ensure the most cost-effective method of transportation is being used to transport the missiles.

**DoD KEY TECHNOLOGY AREA:** Conventional Weapons

**KEYWORDS:** U.S. Navy Ordnance, Ordnance Logistics, Decision Support, Transportation, Cost Analysis

### **OPERATIONAL ANALYSIS OF THE SUSTAINABILITY OF A MOBILE MILITARY PLATFORM**

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**B.S., United States Naval Academy, 1990**

**Master of Science in Operations Research-September 1998**

**Advisors: Donald P. Gaver, Department of Operations Research**

**Patricia A. Jacobs, Department of Operations Research**

**Second Reader: Ronald L. Brown, Department of Operations Research**

This thesis illustrates the use of simulation techniques to evaluate the satisfaction of suitability requirements for a mobile platform carrying payload (for example, an Unmanned Aerial Vehicle with

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sensors) on a military mission (surveillance or reconnaissance). The Institute for Defense Analyses, in support of Director, Operational Test & Evaluation (DOT&E), recently developed a simulation to assist in the analysis of the Predator Unmanned Aerial Vehicle. That simulation has been extended to make it more applicable to a variety of platforms, and the extended simulation has been incorporated into the Military Aircraft Sustainability Simulation (MASS). The primary output from the simulation is an estimate of Effective Time On Station (ETOS), as that depends on platform subsystem reliability and the maintenance resources allocated. ETOS is the long-run percentage of time that the region under surveillance is being covered by at least one operating platform. An analytical model for a single platform also has been developed to augment and assist in verifying the MASS. This thesis shows that MASS can be an invaluable tool for evaluating a platform's suitability for a mission. The simulation can assist during the acquisition process, when the government must decide whether to buy a platform, and the simulation can assist in determining the most effective way to deploy such platforms once they are in use.

**DoD KEY TECHNOLOGY AREAS:** Air Vehicles, Human Systems Interface, Sensors, Ground Vehicles, Modeling and Simulation

**KEYWORDS:** Reliability, Sustainability, Unmanned Aerial Vehicle

### **JOB SATISFACTION AMONG UNITED STATES NAVY AND MARINE CORPS AVIATION OFFICERS—A STUDY OF THE IMPACT ON CAREER RETENTION**

**Daniel J. Sullivan-Major, United States Marine Corps**

**B.S.I.E., Georgia Institute of Technology, 1985**

**Master of Science in Operations Research-September 1998**

**Advisors: William Krebs, Department of Operations Research**

**Samuel E. Buttrey, Department of Operations Research**

**Second Reader: CDR John K. Schmidt, School of Aviation Safety**

United States Naval Aviation Officer retention has been identified by senior-level personnel managers as one of the largest challenges faced by the services in recent years. In robust economic times all branches of the armed forces face the challenge of retaining sufficient highly-trained volunteers. The aviation community is disproportionately affected due to the long lead time associated with aviation officer training and the potential for long-term lucrative civilian job opportunities compared with existing military pay and benefits. This study documents the development of a retention survey aimed to quantify Naval aviation officer attitudes towards job satisfaction and turnover intent. Previous research has indicated that measurements of job satisfaction are the most reliable predictor of one's intent to remain with an existing employer. To best understand this relationship, CART and logistic regression models are proposed to predict Naval aviation officer retention. These models were developed using a principal components analysis of survey data elements. Work satisfaction and age were analyzed in terms of their impact as moderators of the relationship between job satisfaction and retention. Work satisfaction factors were found to be significant in models that predicted turnover intent half again better than if one was to merely provide a sample estimate.

**DoD KEY TECHNOLOGY AREA:** Manpower, Personnel, and Training

**KEYWORDS:** Job Satisfaction, Aviation Officers, U.S. Navy and Marine Corps, Retention, Principal Components Analysis, Regression Analysis

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### OPTIMIZING UNITED STATES MARINE CORPS ENLISTED ASSIGNMENTS

**Brian F. Tivnan-Captain, United States Marine Corps**

**B.S.M.E., University of Vermont, 1992**

**Master of Science in Operations Research-September 1998**

**Advisor: Robert F. Dell, Department of Operations Research**

**Second Reader: Hemant K. Bhargava, Information Systems Academic Group**

The United States Marine Corps (USMC) has 156,000 active duty enlisted Marines and annually orders over 90,000 of them to permanently change station. The Commandant of the Marine Corps requires assignments of the “Right Marine, to the right place with the right skills and quality of life.” USMC manpower planning uses staffing goals (billet requirements) to capture the Commandant’s requirements, but, surprisingly, does not monitor how many Marines fill appropriate staffing goal billets. This thesis finds that although the staffing goals are completely achievable, only 45% of active duty Marines fill a staffing goal billet and 47% of staffing goal billets are under-staffed. The USMC has used the Enlisted Assignment Model (EAM) since the 1970s to help enlisted monitors determine assignments. EAM has several shortcomings. Among these, enlisted monitors reject most of EAM suggested assignments and EAM offers no measure of effectiveness to gauge the quality of its assignments. This thesis presents a network model, EAM-GLOBAL to optimize the by-name assignment of Marines to staffing goal billets. EAM-GLOBAL attempts to assign the “right Marines to the right places” while simultaneously balancing staffing shortages, allowing grade and military occupational specialty substitutions, and minimizing the costs of permanent change of station transfers within the continental United States.

**DoD KEY TECHNOLOGY AREAS:** Manpower, Personnel, and Training, Modeling and Simulation

**KEYWORDS:** Assignment Model, Staffing Goals, Manpower Models, Transportation Model, Network, Elastic Network Model

### AIR FORCE SPECIAL OPERATIONS FORCES LOGISTICS PLANNING AID

**Brett S. Wagner-Lieutenant, United States Navy**

**B.A., Texas Tech University, 1991**

**Master of Science in Operations Research-September 1998**

**Advisor: LTC Charles H. Shaw III, Department of Operations Research**

**Second Reader: David A. Schrady, Department of Operations Research**

This thesis compiles and creates logistics planning factors (usage/consumption rates) for the United States Special Operations Command (USSOCOM) and Air Force Special Operations Forces (AFSOF). The primary goal of this thesis is to provide logistics planning factors to AFSOF logistics planners to aid in the planning and execution process. Incorporating operations research methods to develop these planning factors, certain classes of supply were analyzed according to the specific type of mission, threat, duration, area of operations, number of personnel involved, and time. This thesis includes a graphical, PC-based AFSOF Logistics Planning Aid (AFSOFLOGPLN) using these planning factors. Since planners require a flexible, reliable, and user-friendly system, the logistics planning aid is developed in Microsoft’s Excel with a graphical user interface. This planning aid lets the user input different platforms and mission scenarios and then it computes the logistics requirements to support the AFSOF platform or unit for that mission. Finally, this thesis makes recommendations to the Air Force Special Operations Command logistics planners and USSOCOM that would further improve logistics support for their forces in the future.

**DoD KEY TECHNOLOGY AREA:** Other (Logistics)

**KEYWORDS:** Logistics Planning Factors, U.S.A.F. Special Operations Forces Units and Aircraft, AFSOFLOGPLN Aide

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### AN EXPLORATORY ANALYSIS OF CORRECTIVE MAINTENANCE DURING EXTENDED SURFACE SHIP DEPLOYMENTS

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B.S., University of Colorado, 1990

Master of Science in Operations Research-September 1998

Advisor: Donald P. Gaver, Department of Operations Research

Second Reader: David A. Schrady, Department of Operations Research

The Chief of Naval Operations (CNO) Strategic Studies Group (SSG) XVI study of 1997 proposes to deploy ships for three year periods and rotate crews. This concept is called *Horizon*. An object-oriented, discrete-event simulation is written in Java to stimulate this extended deployment model and evaluate the corrective maintenance requirements for a single-ship deployment. The simulation estimates the mean on-and off-station times of the ship, the mean time between shore-based repair, and the mean operational availability of the ship. The simulation allows the user to perform sensitivity analysis on the input values to determine the significance of the results based upon the measures of the model. The results of this thesis show that the number of shore-base maintenance requirements is affected by inputs of the mean time-to-failure, logistics delay time, and percent of organic repair of the ship.

**DoD KEY TECHNOLOGY AREA:** Modeling and Simulation

**KEYWORDS:** Modeling, Simulation, Navy, Ship, Deployments, Failure, Maintenance

### ANALYSIS OF AMPHIBIOUS SHIP LIFT CAPABILITY

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Master of Science in Operations Research-September 1998

Advisor: Samuel E. Buttrey, Department of Operations Research

Second Reader: Ronald L. Brown, Department of Operations Research

Amphibious ship lift is crucial in supporting operations of Marine Air Ground Task Forces (MAGTF) for a wide range of conflicts. This thesis examines three different aspects of amphibious ship lift capability. First, gross lift capabilities of all amphibious ships in the Navy today are determined. Since some storage space on board a ship is required for access, tie-downs, and other considerations, the second step of this thesis is to use historical load-out data from six-month deployments to derive expected net lift capability from gross lift capability. A three-ship Amphibious Ready Group (ARG) is traditionally required to support a six-month MAGTF deployment. The final part of this thesis utilizes a linear program to determine specific ship combinations that optimize ARG lift capability for both the Pacific and Atlantic Fleets.

**DoD KEY TECHNOLOGY AREA:** Surface/Under Surface Vehicles-Ships and Watercraft

**KEYWORDS:** Amphibious Ship, Broken Stowage Factor, Amphibious Ready Group (ARG)